

STATUS OF THE CLAIMS

1. (CURRENTLY AMENDED) A method of indexing multimedia documents, the method being characterized in that it comprises the following steps:

- a) for each multimedia document, identifying and extracting terms  $t_i$  constituted by vectors characterizing properties of each of the multimedia documents for indexing, which characterizing properties include at least one of such as shape, texture, color, and/or structure of an image, an the energy level, an the oscillation rate or frequency information of an audio signal, and/or a group of characters of a text;
- b) storing the terms  $t_i$  characterizing the properties of each of the multimedia documents in a term base comprising a set of P terms, where P is an integer;
- c) determining a maximum number (N) of desired concepts combining the most pertinent terms  $t_i$ , where N is an integer less than P, with each concept  $c_i$  being designed to combine all terms  $t_i$  based on a relationship of that are neighboring from the point of view of their characterizing propertiescharacteristics;
- d) calculating the matrix T of distances between the terms  $t_i$  of the term base of P terms;
- e) decomposing the set of P terms of terms  $t_i$  of the term base into N portions  $P_j$  ( $1 \leq j \leq N$ ) such that the set of P terms =  $P_1 \cup P_2 \dots \cup P_j \dots \cup P_N$ , each portion  $P_j$  comprising a set of terms  $t_{ij}$  and being represented by a concept  $c_j$ , the terms  $t_i$  being distributed in such a manner that terms that are farther away are

to be found in distinct portions  $P_1$ ,  $P_m$  while terms that are closer together are to be found in the same portion  $P_1$ ;

f) structuring a concept dictionary so as to constitute a binary tree in which each leaf of the binary tree the leaves contains at the concept[[s]]  $c_i$  of the dictionary and each node the nodes of the binary tree contains the information necessary for scanning the tree during a stage of identifying a multimedia document by comparing it with previously-indexed documents; and

g) constructing a fingerprint base made up of at the set C of concepts  $c_i$  representing the terms  $t_i$  of the multimedia documents to be indexed, each multimedia document being associated with a fingerprint that is specific thereto.

2. (CURRENTLY AMENDED) An indexing method A method of indexing multimedia documents according to claim 1, characterized in that each concept  $c_i$  of the fingerprint base is associated with a data set comprising at the number of terms, in  $No.$   $T_L$  in the multimedia documents in which said the concept  $c_i$  is present.

3. (CURRENTLY AMENDED) An indexing method A method of indexing multimedia documents according to claim 1, characterized in that for each multimedia document having a corresponding in which a concept  $c_i$  is present, a fingerprint of the corresponding concept  $c_i$  is registered in the multimedia document, said fingerprint containing at least one of the frequency of occurrence of with which the corresponding concept  $c_i$  occurs, the identities of concepts neighboring the corresponding concept  $c_i$  in the multimedia document, and a score which is a mean value of similarity measurements between the corresponding concept  $c_i$  and

the terms  $t_i$  of the multimedia document that are most proximate  
the closest to the corresponding concept  $c_i$ .

4. (CURRENTLY AMENDED) An indexing methodA method of indexing  
multimedia documents according to claim 1, further  
comprising: characterized in that it comprises a step of  
optimizing the step of decomposing partitioning of the set of  
P ef-terms of the term base by decomposing to decompose said set  
of P terms into M classes  $C_i$  (in which  $1 \leq i \leq M$ , where M is an  
integer and  $M \leq P$ ), so as to reduce a the distribution error of  
the set of P ef-terms in the term base into N portions ( $P_1$ ,  $P_2$ , ...,  
 $P_N$ ) where each portion  $P_i$  is represented by the terms  $t_i$  that are  
taken as the concept  $c_i$ ,

the distribution error that is committed ( $\epsilon$ ) being such that:

$$\epsilon = \sum_{i=1}^N \epsilon_{t_i}$$

wherein  $\epsilon_{t_i} = \sum_{t_j \in P_i} d^2(t_i, t_j)$  is the distribution error committed by  
replacing the terms  $t_i$  of a portion  $P_i$  with the terms  $t_i$ .

5. (CURRENTLY AMENDED) An indexing methodA method of indexing  
multimedia documents according to claim 4, characterized in that  
it comprises the following steps:

- i) decomposing the set of P ef-terms into two portions ( $P_1$   
and  $P_2$ );
- ii) determining a first term the two terms  $t_i$  and a second  
term  $t_j$  of the set of P terms that are the farthest apart,

corresponding to the greatest distance  $D_{1j}$  of the distance matrix  $T$  of distances;

iii) for each term  $t_k$  of the set of P terms, examining to see whether the distance  $D_{ki}$  between the term  $t_k$  and the first term  $t_i$  is less than the distance  $D_{kj}$  between the term  $t_k$  and the second term  $t_j$ , and if so, allocating the term  $t_k$  to the portion  $P_1$ , and otherwise allocating the term  $t_k$  to the portion  $P_2$ ; and

iv) iterating step (i) until the desired number N of portions  $P_i$  has been obtained, and on each iteration applying the steps (ii) and (iii) on the first and second terms of the portions  $P_1$  and  $P_2$ .

6. (CURRENTLY AMENDED) An indexing method~~A method of indexing multimedia documents according to claim 4, further comprising: characterized in that it includes~~

optimization starting from  $N$  disjoint portions  $\{P_1, P_2, \dots, P_N\}$  of the set of P terms and  $N$  terms  $\{t_1, t_2, \dots, t_N\}$  representing them in order to reduce the decomposition error of the set of P terms into  $N$  portions, further comprising~~and in that it comprises the following steps:~~

i) calculating a corresponding the centers of gravity  $C_i$  for each of the portion~~[[e]]~~  $P_i$ ;

ii) calculating a corresponding decomposition error using:

errors- 
$$\sum_{t_j \in P_i} d^2(C_i, t_j),$$

replacing the terms  $t_j$  by center of gravity terms  $C_i$ ; and calculating a corresponding distribution error using:

$$\epsilon t_i = \sum_{t_j \in P_1} d^2(t_i, t_j)$$

whenby replacing the terms  $t_i$  of the portion  $P_1$  respectively by  $\epsilon_i$  and by the terms  $t_i$ ;

iii) comparing  $\epsilon t_i$  and  $\epsilon C_i$  and replacing the terms  $t_i$  by the center of gravity terms  $C_i$  if  $\epsilon C_i \leq \epsilon t_i$ ; and

iv) calculating a new distance matrix T between the terms  $t_i$  of the term base and the process of decomposing the set of  $P$  of terms of the term base into N portions, unless a stop condition is satisfied with

$$\frac{\epsilon C_t - \epsilon C_{t+1}}{\epsilon C_t} < \text{threshold},$$

where  $\epsilon C_t$  represents the decomposition error committed at instant  $t$ .

7. (CURRENTLY AMENDED) An indexing methodA method of indexing multimedia documents according to claim 1, wherein characterized in that for the purpose of structuring the concept dictionary includes:

producing a navigation chart is produced iteratively on each iteration, beginning by splitting the set  $C$  of concepts into two subsets, and then selecting one subset on each iteration until the desired number of groups is obtained or until a stop criterion is satisfied.

8. (CURRENTLY AMENDED) An indexing methodA method of indexing multimedia documents according to claim 7, wherein characterized in that the stop criterion is satisfied when is constituted by the

fact that each of the two subsets obtained is are all homogeneous and has a with small standard deviation.

9. (CURRENTLY AMENDED) An indexing methodA method of indexing multimedia documents according to claim 7, wherein characterized in that during the structuring of the concept dictionary includes:

determining navigation indicators are determined from a matrix  $M = [c_1, c_2, \dots, c_N] \in \mathbb{R}^{p \times N}$  of the set C of concepts  $c_i \in \mathbb{R}^p$  where  $c_i$  represents a concept of p values, by implementing the following steps:

- i) calculating a representative  $w$  of the matrix M;
- ii) calculating at the covariance matrix  $\tilde{M}$  between the elements of the matrix M and the representative  $w$  of the matrix M;
- iii) calculating a projection axis  $u$  for projecting the elements of the matrix M;
- iv) calculating at the value  $pi = d(u, Ci) - d(u, w)$  and decomposing the set C of concepts  $\{C\}$  into two subsets (C1 and C2) as follows:

$$\begin{cases} c_i \in C1 \text{ if } pi \leq 0 \\ c_i \in C2 \text{ if } pi > 0 \end{cases}$$

v) storing a data set the information  $\{u, w, |p1|, p2\}$  in the node associated with the set C of concepts, where  $p1$  is at the maximum of all  $pi \leq 0$  and  $p2$  is at the minimum of all  $pi > 0$ , the data set  $\{u, w, |p1|, p2\}$  constituting the navigation indicators in the concept dictionary.

10. (CURRENTLY AMENDED) An indexing methodA method of indexing multimedia documents according to claim 1, characterized in that

~~both the structural components and the complements of said structural components constituted by the textural components of the~~ an image of the multimedia document are analyzed, and in that:

a) while analyzing the structural components of the image:

a1) boundary zones of the image structures are distributed into different classes depending on the orientation of a the local variation in intensity so as to define structural support elements (SSEs) of the image; and

a2) performing statistical analysis to construct terms constituted by vectors describing the local properties and the global properties of the structural support elements;

b) while analyzing the textural components of the image:

b1) detecting and performing parametric characterization of a purely random component of the image;

b2) detecting and performing parametric characterization of a periodic component of the image; and

b3) detecting and performing parametric characterization of a directional component of the image;

c) grouping the set of descriptive elements of the image in a limited number of concepts constituted firstly by the terms describing the local properties and the global properties of structural support element and secondly by the parameters of the parametric characterizations of the random, periodic, and directional components defining the textural components of the image; and

d) for each document, defining a fingerprint from the occurrences, the positions, and the frequencies of said limited number of concepts.

11. (CURRENTLY AMENDED) ~~An indexing method~~A method of indexing multimedia documents according to claim 10, characterized in that the local properties of the structural support elements taken into consideration for constructing terms comprise at least one of the support types selected from amongst a linear strip or a curved arc as a support, the length and width dimensions of the support, at the main direction of the support, and at the shape and the statistical properties of the pixels constituting the support.

12. (CURRENTLY AMENDED) ~~An indexing method~~A method of indexing multimedia documents according to claim 10, characterized in that the global properties of the structural support element taken into account for constructing terms comprise at least at the number of each type of support and at the spatial disposition thereof.

13. (CURRENTLY AMENDED) ~~An indexing method~~A method of indexing multimedia documents according to claim 10, wherein characterized in that during analysis of the structural components of the image, a prior test is performed to detect whether at least one structure is present in the image, and in the absence of any structure, the method passes directly to the step of analyzing the textural components of the image.

14. (CURRENTLY AMENDED) ~~An indexing method~~A method of indexing multimedia documents according to claim 10, characterized in that in order to distribute~~decompose~~ boundary zones of the image structures into different classes, starting from at the digitized image defined by at the set of pixels  $y(i,j)$  where  $(i,j) \in I \times J$ , where  $I$  and  $J$  designate, respectively, at the number of rows and at the number of columns of the image, at the vertical gradient image

$g_v(i,j)$  where  $(i,j) \in I \times J_v$ , and the horizontal gradient image  $g_h(i,j)$  with  $(i,j) \in I \times J$  are calculated, and the image is partitioned depending on the local orientation of its gradient into a finite number of equidistant classes, the image containing the local orientation of its gradient being defined by the equation:

$$O(i,j) = \arctan \left[ \frac{gh(i,j)}{gv(i,j)} \right]$$

the classes constituting support regions likely to contain significant support elements are identified, and based on the basis of the support regions, significant support elements are determined and indexed using predetermined criteria.

15. (CURRENTLY AMENDED) An indexing methodA method of indexing multimedia documents according to claim 1, characterized in that while indexing a multimedia document comprising video signals, terms  $t_i$  are selected that are constituted by key-images representing groups of consecutive homogeneous images, and concepts  $c_i$  are determined by grouping together terms  $t_i$ .

16. (CURRENTLY AMENDED) An indexing methodA method of indexing multimedia documents according to claim 15, characterized in that in order to determine key-images constituting terms  $t_i$ , a score vector SV is initially generated comprising a set of elements SV(i) representative of the difference or similarity between a first the content of an image of index i and a second the content of an image of index i-1, and the score vector SV is analyzed in order to determine key-images which correspond to maximums of the values of the set of elements SV(i) of the score vector SV.

17. (CURRENTLY AMENDED) ~~An indexing method~~ A method of indexing multimedia documents according to claim 16, characterized in that an image of index  $j$  is considered as being a key-image if:

-athe value  $SV(j)$  of the corresponding element of the score vector  $SV$  is a maximum and the value  $SV(j)$  is situated between two minimums  $minL$  and  $minR$ , and

aif the minimum  $M1$  given by such that

$$M1 = (|SV_{(j)} - minL|, |SV_{(j)} - minR|)$$

is greater than a given threshold.

18. (CURRENTLY AMENDED) ~~An indexing method~~ A method of indexing multimedia documents according to claim 1, characterized in that while indexing a multimedia document comprising audio components, the multimedia document is sampled and decomposed into frames, which frames are further~~subsequently~~ grouped together into clips that are each being characterized by the terms  $t_i$  constituted by a parameter vector.

19. (CURRENTLY AMENDED) ~~An indexing method~~ A method of indexing multimedia documents according to claim 18, characterized in that each~~[a]~~ frame comprises about 512 samples to about 2,048 samples of the sampled audio document.

20. (CURRENTLY AMENDED) ~~An indexing method~~ A method of indexing multimedia documents according to claim 18, characterized in that the parameters taken into account to define the terms  $t_i$  comprise

time information selected from the group consisting of corresponding to at least one of the following parameters: ~~an~~ the energy level of the audio signal frames, ~~an~~ the standard deviation of frame energy levelsies in the clips, ~~an~~ the sound variation ratio, ~~an~~ the low energy ratio, ~~an~~ the rate of oscillation about a predetermined value, ~~an~~ the high rate of oscillation about a predetermined value, ~~an~~ the difference between ~~an~~ the number of oscillation rates above and below the mean oscillation rate for the frames of the clips, ~~an~~ the variance of the oscillation rate, or ~~an~~ the ratio of silent frames.

21. (CURRENTLY AMENDED) ~~An indexing method~~ A method of indexing multimedia documents according to claim 18, characterized in that the parameters taken into account for defining the terms  $t_i$  comprise frequency information selected from the group consisting of: ~~corresponding to at least one of the following parameters:~~

~~an~~ the center of gravity of ~~an~~ the frequency spectrum of ~~an~~ the short Fourier transform of ~~an~~ the audio signal, ~~an~~ the bandwidth of the audio signal, ~~an~~ the ratio between ~~an~~ the energy level in a frequency band to ~~an~~ the total energy level in the entire frequency band of the sampled audio signal, ~~an~~ the mean value of spectrum variation of two adjacent frames in a clip, and ~~an~~ the cutoff frequency of a clip.

22. (CURRENTLY AMENDED) ~~An indexing method~~ A method of indexing multimedia documents according to claim 18, characterized in that the parameters taken into account for defining the terms  $t_i$  comprise at least energy modulation at 4 Hz.

23. (CURRENTLY AMENDED) An indexing method ~~A method of indexing multimedia documents according to claim 1, characterized in that the shape[[#]] of the image of the multimedia document are analyzed using the following steps:~~

- a) performing multiresolution followed by decimation of the image;
- b) defining the image in polar logarithmic space;
- c) representing at the query image or an image portion by its Fourier transform H;
- d) characterizing the Fourier transform H as follows:
  - d1) projecting H in a plurality of directions to obtain a set of vectors of dimension equal to at the projection movement dimension; and
  - d2) calculating the—statistical properties of each projection vector; and
- e) representing the shape of the image by a term [[t<sub>4</sub>]] constituted by values for the statistical properties of each projection vector.